Westinghouse Electric Company

# Pulsed Gamma Neutron Activation Analysis (PGNAA) System for the Assay of RCRA Metals in Mixed Waste

## Technology Need:

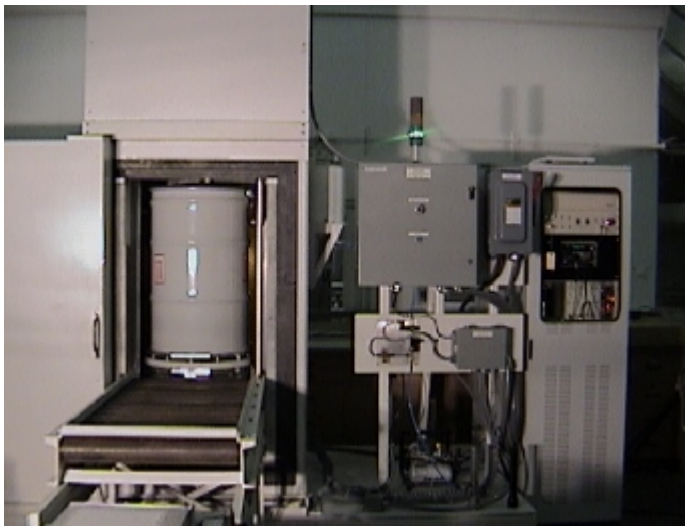
The presence of certain metals defined as hazardous by the Resource Conservation and Recovery Act (RCRA) in mixed-waste drums can seriously limit the operation of waste treatment processes. Excessive concentrations of these metals result in effluent stream concentrations which exceed regulatory limits and/or chemically interfere with treatment process control. There is currently no adequate nondestructive assay (NDA) technique to monitor the RCRA metal content of mixed-waste drums. Analytical batch sampling is used instead to screen out drums with large RCRA metal concentrations. However, this method is expensive, time-consuming, and usually results in the generation of secondary waste. Non-intrusive technologies capable of assaying RCRA metals in containerized mixed wastes are needed to facilitate the treatment and disposal of mixed waste.

## Technology Description:

PGNAA shows great promise as a technique for the NDA of RCRA metals in sealed containers. This system employs an approach whereby the energy spectra of gamma rays produced from neutron-induced reactions in the sample are acquired by a germanium detector in four successive time domains ("groups") following each pulse of a 14-MeV neutron generator. This timing scheme results in the separation of fast neutron-induced reactions, which occur concurrently with the neutron pulse (group 1), from thermal neutron-induced reactions, which occur on a time scale governed by the mean thermal neutron capture lifetime (groups 2 and 3), and from the decay events of neutron activation products with half lives ranging from milliseconds to minutes (group 4). With this approach, prompt gamma rays originating from fast and thermal neutron capture reactions as well as decay gamma rays emitted by short-lived activation products can be detected with superior signal-to-background ratios.

## Benefits:

- Characterization of RCRA metal content of mixed-waste container can be done in real- or near real-time.
- PGNAA is cost-efficient relative to sampling and laboratory analysis.
- Hazards involved with opening of sealed mixed-waste containers are reduced.



**View of PGNAA Drum Assay Prototype**

- Use of PGNAA does not generate secondary waste.
- A PGNAA system can readily be configured for deployment in the field.
- Other elements of interest such as chlorine and boron can also be detected by PGNAA.

## Status and Accomplishments:

The objective of this project is to design, build and demonstrate a field-deployable PGNAA prototype capable of characterizing the RCRA metal content of 55-gallon drums containing mixed-waste sludge. Potential interfering mechanisms presented by typical mixed-waste sludge were studied through a combination of computational modeling and experimental testing. Computational modeling was also utilized to optimize the hardware configuration of the PGNAA system for enhanced sensitivity in the analysis of 55-gallon drums.

Modeling results were verified by experiments involving the assay of surrogate waste drums. Surrogate waste drums were prepared at the direction of personnel from the Idaho National Engineering and Environmental Laboratory (INEEL) who are familiar with the types of sludge waste encountered in practice.

The ability of a laboratory PGNAA system to noninvasively detect and quantify low levels of RCRA metals Hg, Cd and Pb in eight-gallon drums of surrogate waste has been demonstrated. Consequently, a PGNAA prototype unit capable of assaying 55-gallon drums was designed and built. System calibration and testing tasks were completed and the system was shipped to Argonne National Laboratory-West for field demonstration. Eight 55-gallon drums of mixed-waste sludge having mercury concentrations ranging from 0 to 120 ppm were selected as test samples.

Comparison of the PGNAA measured values with chemical analysis results indicated that mercury concentrations greater than 60 ppm could be detected by the prototype PGNAA system, consistent with performance objectives. The PGNAA NDA results also indicated that the system was able to detect chlorine. In addition, information on the axial distribution of some of the Transuranic nuclides present in the waste drums could also be extracted from the assay data.

The PGNAA prototype performed reliably throughout the measurements, and the demonstration was completed on schedule. Based on this successful demonstration, a study of the sensitivity of this PGNAA system for the detection of other RCRA metals of interest in sludge was initiated.

Current testing is focused on the RCRA metals selenium and silver. INEEL prepared surrogate waste samples of silver and selenium for verifying the limit of detection for these two RCRA elements.

It should be noted that the PGNAA development program underwent an independent peer review organized by the ASME in January of 2002. The outcome of this review was overall favorable to the program. The Review Panel endorsed the technical approach adopted in the project, and unanimously recommended that the project be continued based on technical merit. Further, the Review Panel made several recommendations for future work, including some related to the extension of PGNAA to the assay of debris-type waste.

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## Online Resources:

Office of Science and Technology, Technology Management System (TMS), Tech ID # 2226
http://ost.em.doe.gov/tms

The National Energy Technology Laboratory Internet address is http://www.netl.doe.gov

For additional information on this technology, please visit http://www.westinghouse.com/